it as a genus ('genre') in essentially the same terms as Cuvier had done but adding data respecting the intestines. The additional data, however, were simply taken from Cuvier's definition of *Synbranchus* on the assumption that what was true of the latter was also of the former. The date of the title page of the 'Dictionnaire' is 1816, the year previous to that of the title page of the 'Règne Animal' (1817).

Cloquet's notice is important inasmuch as Cuvier gave only the French form ('les Alabès') of the name which many naturalists of the present day would regard as inadmissible. Cloquet's addition of the Latin name is also prior to Oken's similar action (*Isis*, 1817, 1183).

A. Valenciennes furnished for the 'Dictionnaire Universel d'Histoire Naturelle' (I., 237, 1841) a notice of the genus *Alabes* defining it by the single jugular branchial aperture, small pectorals, small opercle, and three branchiostegal rays, ignoring the alleged disk. He also ignored the attribution of the Indian habitat, and referred to Péron as the collector —'On ne connaît encore qu'une seule esp. de ce g., rapportée par Péron, lors du voyage du capitaine Baudin aux terres australes.' This solves the question as to habitat raised by Vaillant (p. 148).

I had long ago considered the possibility of the identity of *Alabes* and *Cheilobranchus* but the evidence was altogether insufficient to certify it, and had not the determination been effected by means of the types of *Alabes*, it might have been better to have rejected that name as indeterminable. As it is, it is perhaps necessary to revive it as the prior designation of *Cheilobranchus* and at the same time to substitute the family name ALABETIDÆ and the superfamily term ALABETOIDEA. In 1872, recognizing the decided difference between the genus and the Synbranchidæ, I proposed for it the family Chilobranchidæ and later (1896) further removed it from the Synbranchidæ as a superfamily (Chilobranchoidea). I have always regarded the group as having no determinate relationship to the typical Symbranchia and in 1872 retained it doubtfully among the Apodes ('Apodes? incerti sedis'). In 1885 ('Standard Natural History,' III., 100), contrasting it with the true Symbranchia I have remarked, 'on the other hand, the Chilobranchidæ (a family of doubtful relationship) have only about twenty-one abdominal and fifty-two caudal vertebræ.' The data are still quite insufficient to determine the affinities of the genus but sufficient to assure us that it is not related to either the Symbranchia or the Blenniidæ. It is to be hoped that a comparative study of the skeleton may be made. It should above all be ascertained what is the nature of the paired 'fins' and for this purpose the morphology of the supporting bones (if any) should be elucidated.

THEO. GILL.

THE FUNCTIONS OF THE FINS OF FISHES.

THE communication in a recent number of SCIENCE (December 15, 1905) by A. Dugès, entitled 'Note on the Functions of the Fins of Fishes,' deserves some attention, if only to correct some of the impressions it leaves with the reader. While the observations recorded in the above-mentioned paper are interesting enough as evidence from one more source, it must not be thought, as the author states, that the functions of the various fins have not been 'treated in a practical manner up to the present,' nor is it true that the regeneration of the fins 'has not yet been observed, or at least not published.'

For the latter point I refer the author to the work of Professor T. H. Morgan on 'Regeneration in Teleosts'[1] and 'Further Experiments on the Regeneration of the Tail of Fishes,'[2] dealing with the results of experimentation on the regeneration of paired and unpaired fins in five genera, *Tautogolabrus* (*Ctenolabrus*), *Opsanus* (*Batrachus*), *Fundulus*, *Stenotomus* and *Decapterus*.

As to the use of the fins, H. Strasser published in 1882[3] a good account of the move-

[1] *Archiv für Entwickelungsmechanik der Organismen*, X., 1900, pp. 120–134.

[2] *Ibid.*, XIV., 1902, pp. 539–561.

[3] 'Zur Lehre von der Ortsbewegung der Fische durch Beugungen des Leibes und der unpaaren Flossen.'

ment of fishes, dealing especially with the caudal as a 'propulsatorisches Organ.' The use of the tail and the flexion of the body have been generally recognized by writers on the fishes. The experiments performed by Dugès were made on sharks twenty years ago by Paul Mayer and accurately described in 'Die unpaaren Flossen,'[4] with practically the same results.

The account of Mr. Dugès called to mind certain of my own observations made several years ago, but not published. As these were not entirely in accord with those of the above writer I decided to repeat the studies for the sake of confirming either my own work or that of Mr. Dugès. Director Charles H. Townsend, of the New York Aquarium, very kindly granted me space and material. I have to thank also Mr. W. I. DeNyse, of the aquarium, who assisted me in many ways and confirmed some of the observations. The experiments were chiefly upon *Fundulus heteroclitus,* a hardy species in which the fins are of rather large size.

Space will not permit the recounting here of all the experiments made by removing the fins in all possible combinations, but a few of the results may be stated. When a single pectoral fin was removed the fish tended to turn partly on one side, due probably to the action of the pectoral of the opposite side. This, however, the fish soon learned to regulate. After the removal of both pectorals the fish when swimming slowly apparently moved as usual, but when forced to turn quickly it was unable to accurately balance or otherwise undergo movements requiring nice adjustment. This is much more marked in the short, compressed or rhomboidal type of fish. A scup (*Stenotomus chrysops*) with both pectorals removed is very helpless when attempting to undergo certain movements which are ordinarily performed with the greatest ease. A study of the movements of the many species of fishes in the New York Aquarium is entirely confirmatory of the view that one function of the pectoral is to balance and accurately adjust the fish in swimming.

[4] *Mitth. z. Zool. Sta., Neapel,* VI., 1886.

Another very evident function of the pectoral, at least in many species, is locomotion. *Fundulus* occasionally swims slowly forward with the use of the pectorals alone, or it can reverse the movement and swim backward very slowly, and I have even seen them swim slowly in a circle using only one pectoral. These are not to be considered the most ordinary movements in *Fundulus,* but at least they show that the fins are capable of being used for these purposes. In this connection the doctor-fish (*Teuthis hepatus*) is one of the most interesting. This active fish swims rapidly around the aquarium tank with the body apparently quite rigid and, using the pectorals like a pair of wings, can swim either forward or backward. The tautog (*Tautoga onitis*) often swims leisurely, using only the pectorals and dorsal.

Another well-marked function of the pectorals is their use as a drag or brake in stopping. It can be noted in the movements of many fishes in the aquarium that in stopping the pectorals, and often the pelvics also, are thrown out at right angles to the body, thereby increasing very greatly the resistance to the water. Fishes with the pectorals removed would at first frequently run against the side or bottom of the tank, but later they learned to avoid this by a strong movement of the tail. During the course of my experiments on this point I was pleased to find in Dr. H. H. Swinnerton's latest paper[5] a statement to the same effect, and in a recent conversation Professor R. S. Lull offered the same suggestion.

With regard to the observation made by Mr. Dugès that the pectorals are moved when the fishes are stationary in order 'to produce currents in the water to renew the portions of this which had already yielded their oxygen to the gills and remained charged with carbonic anhydride,' I must say that, while at first glance it looks like a probable explanation, a little study of various types of fishes will serve to show the fallacy of the statement. In the first place the water is not renewed at

[5] 'A Contribution to the Morphology and Development of the Pectoral Skeleton of Teleostomes,' *Q. J. M. S.,* November, 1905.

the gill region in breathing but is taken in at the mouth and forced backward over the gills and out in a backward direction. Secondly, there are certain types of fishes which possess no pectoral fins and yet manage to keep up their supply of oxygen. Thirdly, there are certain fishes which live upon the bottom, like the skates, or even buried under the sand, as the flounders, which are unable to make any such use of the pectorals and yet breathe without difficulty. Lastly, it is a point of observation without a single exception in my experience that the ordinary, actively swimming type of fish when resting on the bottom does not move the fins at all. Observations of several years' standing, on fishes in and out of aquaria, have recently been supplemented by careful studies at the New York Aquarium on many different types of fishes, both fresh water and marine, and the result is invariably as above stated.

On the other hand, all the fishes that I have observed use the pectorals when they are suspended in the water. Moreover, other fins are often brought into use at the same time. Thus the elongate pike (*Lucius*) and gar (*Lepisosteus*) are seen to move the pelvic fins slowly, coordinately with the pectorals, and short-bodied forms such as the butterfly-fish (*Chætodon*) move the pectorals and caudal, while in species intermediate in form the caudal, anal and dorsal may, any or all, be used in addition to the paired fins when suspended in the water. This array of facts makes it quite clear that the function of the pectorals when the fish is stationary is that of equilibration and not the removal of water charged with carbon dioxide.

It is impossible to formulate a rule for the pectoral fins which will cover all cases, since in the more or less aberrant species this fin may be used for creeping on the bottom or even for progress on land or in the air, or it may enter into the formation of a sucking disc, or rarely may be absent; but as far as the usual swimming type of fish is concerned, the following uses are most in evidence:

Guiding and balancing the body in swimming;
To act as a brake in arresting the progress;
Equilibration when suspended stationary in the water, and
Locomotion, either forward or backward.

The pelvic fins are generally used much in the same way as the pectorals, though of less importance. The vertical fins may assist the caudal in locomotion or the pectorals in balancing. In terete types of fishes the dorsal and anal seem to have much the same function as a centerboard on a boat, to prevent the body from slipping sidewise through the water when the caudal portion is flexed in making the stroke. In fishes of this type which have had these fins removed the body is seen to wriggle to a greater extent than in those which possess the fins.

In conclusion, I wish to say that no one appreciates better than the writer the highly adaptive character of the fins, especially those of teleosts, and that any one who searches for exceptions will find them—it would probably be much more difficult to find two species in which all the fins are used in exactly the same manner—and yet I believe that the general functions of the fins are about as above outlined.

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January 18, 1906.

COLUMBIA FIELD WORK IN 1905 INTERCOLLEGIATE FIELD COURSES IN GEOLOGY.

DURING the latter part of May and early part of June, 1905, a party of nine graduate students from the department of geology, Columbia University, under the guidance and direction of Professor A. W. Grabau, made a somewhat extended field trip through New York State, visiting and studying in considerable detail many of the type localities and typical developments of the Paleozoic formations. The object of the trip was, by actual field work, to make each student familiar with the general appearance and lithological character of the various formations as they occur in the field, as well as their stratigraphical relation to one another and to the underlying crystalline rocks, and by personal collecting, to make him familiar with the characteristic fossils of each formation. Whenever opportunity was afforded a study was also made